Title: Homer DePot Wants To Turn Green :)

Brief Overview:

This unit is designed to give students the opportunity to see various tiered curricula used in a realistic setting. It focuses on the mastery of the following major concepts:

- The ability to link and analyze data using scatter plots and curves of best fit (regression).
- The concept of volume and the linear relationships as one dimension (height) continues to vary.
- Finding points of intersection and interpreting the meaning behind them.

NCTM Content Standard/National Science Education Standard:

- Understand and compare the properties of classes of functions, including exponential, polynomial, rational, logarithmic, and periodic functions.
- Interpret representations of functions of two variables.
- Use symbolic algebra to represent and explain mathematical relationships;
- Judge the meaning, utility, and reasonableness of the results of symbol manipulations, including those carried out by technology.
- Identify essential quantitative relationships in a situation and determine the class or classes of functions that might model the relationships.
- Draw reasonable conclusions about a situation being modeled.
- Make decisions about units and scales that are appropriate for problem situations involving measurement.
- Understand the meaning of measurement data and categorical data, of univariate and bivariate data, and of the term variable.
- Understand histograms, parallel box plots, and scatterplots and use them to display data.
- For bivariate measurement data, be able to display a scatterplot, describe its shape, and determine regression coefficients, regression equations, and correlation coefficients using technological tools.
- Display and discuss bivariate data where at least one variable is categorical.
- Build new mathematical knowledge through problem solving.
- Solve problems that arise in mathematics and in other contexts.
- Apply and adapt a variety of appropriate strategies to solve problems.
- Monitor and reflect on the process of mathematical problem solving.
- Communicate their mathematical thinking coherently and clearly to peers, teachers, and others.
- Analyze and evaluate the mathematical thinking and strategies of others.
- Recognize and use connections among mathematical ideas.
- Understand how mathematical ideas interconnect and build on one another to produce a coherent whole.
- Recognize and apply mathematics in contexts outside of mathematics.

- Create and use representations to organize, record, and communicate mathematical ideas.
- Use representations to model and interpret physical, social, and mathematical phenomena.

Grade/Level:

Grades 10 – 12/Algebra 2

Duration/Length:

Approximately 3 to 4 45-minute class periods.

Student Outcomes:

Students will:

- Calculate percentages of energy savings.
- Calculate linear relationships between height and volume of a prism as height varies (base area remains constant).
- Calculate a curve of best fit given the data collected.
- Analyze the connections between the curves, calculate the points of intersection and interpret the meaning of the points of intersection.
- Model the situation with the use of spreadsheet software (this project gives a lesson using Microsoft Excel).
- Effectively communicate with mathematical arguments the results of their findings.
- Be able to work as a team to solidify these findings.
- Construct a spatially accurate graph showing the mathematical relationships they used to solve a practical problem.

Materials and Resources:

- TI-83 or TI-84 graphing utility or any calculator with similar features.
- Computer access to Excel.
- Technology sheets that include instructions for:
  1) *Graphing Scatter Plots and Finding Curves of Best Fit*.
  2) *Generating a Graph in a Spreadsheet Program: Part One*.
  3) *Generating a Graph in a Spreadsheet Program: Part Two*.
- Worksheets:
  1) *Finding Curves of Best Fit: A Quick Review.*
  2) *Insulation Project.*
- Information Sheet: *Rubric for Oral Presentation.*

Development/Procedures:

Lesson 1

Pre-assessment – Have students create scatter plots given tables of values and let them determine which regression formula would best fit the data. It is not necessary to overanalyze at this step. This can be determined by sight. For example: linear regression vs. quadratic regression vs. exponential regression vs. logarithmic regression.

Teacher note: Consider distributing the worksheet *Finding Curves of Best Fit*: *A Quick Review* as homework the night before this lesson. Assist students as they reacquaint themselves with curves of best fit.

Launch – Quickly review the scatter plots, and then take the students to the computer lab and introduce them to some of the basics features of the Excel Program and how to generate graphs.

Teacher Facilitation – Quickly review student solutions to the worksheet *Finding Curves of Best Fit*: *A Quick Review*. Take the students to the computer lab and distribute the two Excel instruction sheets *Generating a Graph in a Spreadsheet Program, Part One* and *Part Two*.

Teacher note: This first lesson is about laying the necessary groundwork so that the student may focus on the application problem at hand. Depending on the students' exposure to spreadsheet programs, this could take more than one lesson. The intent is to get the student to have the freedom to analyze the problem without worrying about the mechanics that help us to solve the problem. Also, the pre-assessment could be the previous night's homework assignment so as to give extra time to accomplish the launch.

Student Application – Students complete the pre-assessment *Finding Curves of Best Fit*: *A Quick Review*. Allow students to share their solutions and discuss results. Students demonstrate their mastery of Excel by providing printouts of the scatter plot graph and the line/points graph from their two technology worksheets.

Embedded Assessment – Students demonstrate their mastery of Excel by providing printouts of the scatter plot graph and the line/points graph from their two technology worksheets.

Reteaching/Extension – Students that have experience with Excel will likely finish earlier. These students should engage as “coaches” for other students.

Lesson 2

Pre-assessment – Summarize what the students learned in the previous lesson. The students share the graphs they generated from Excel.

Launch – Hand out “Insulation Project,” and read through the background scenario with the students. Students might need an explanation about what blown-in attic insulation refers to (as opposed to insulation in a wall or somewhere else). Pictures, or possibly physical samples, may help. Some students may have experience with insulation, and this is a great opportunity for them to share their knowledge.

Teacher Facilitation – Ask the students to determine the best-fit curve for the relationship between depth of insulation and percentage of energy savings. Students should enter the data into their graphing calculators, graph the data, and determine a best-fit curve. Circulate around the room during this process to make sure each student is following the exercise successfully and to identify students who need help. Challenge the students to interpret the graph and to explain why the graph rises sharply but eventually levels off.

After students have finished this brief exercise, each student should understand the best-fit curve for the data.

Student Application – Form groups of three or four students. The teacher can determine how best to do this (students form their own groups, or teacher assigns pre-determined groups), but an important factor is to make sure that each student who needs help is in a group with other students who are performing successfully.

At this point, assign the exercise task to each student group: Determine how many inches of insulation Homer needs to blow into his attic in order to save the same amount of money on energy in two years as he will spend on insulation.

Encourage the students to keep investigating how to approach the solution until one or more successful approaches emerge. This is the focus of the embedded assessment. At the point where at least one successful approach emerges, have the group prepare a presentation on their solution during the next lesson.

Embedded Assessment – Two embedded assessments are part of this lesson:

- An assessment of when to conclude the review of topics (best-fit curves; English metrics and volumes).

- An assessment of when the students, as a class, have sufficiently investigated an approach to the problem. The groups can begin work by themselves with good probability of success.

Both of the embedded assessments are judgment calls based on interaction with the students. The teacher will assure that at least two-thirds of the students respond to questions and/or demonstrate through discussion an understanding of the topic and competence to perform the next step. Those students who do not respond or demonstrate sufficiently should be placed on teams with students who do demonstrate understanding.

Reteaching/Extension – The embedded assessment may reveal that students are not prepared to make the step toward the scenario or the group work. If this is the case, reteaching is essential. An additional lesson may be needed. The whole exercise is an event of deepening knowledge about mathematical relationships and the practical application of math in day-to-day life. The teacher must be prepared to spend more time to make sure that the objectives are met.

Lesson 3

Pre-assessment – Summarize the previous lesson, recalling the "Insulation Project." Ask for questions the students might have about the project, and invite the other students in the class to provide ideas, suggestions, and guidance.

Launch – Organize the class into the same groups as in the previous lesson. Have the groups give a summary of the approach the group is taking to solve the exercise and what the group has accomplished so far.

Each group should have made progress on an approach that defines the two cost functions:

- The cost of the insulation project as a function of depth of insulation.

- The energy bill savings as a function of depth of insulation.

Each group should recognize that the group is trying to find where the two functions have a solution (where the graphs of the two functions intersect). If any group is not making satisfactory progress, the teacher can have two groups work together until a slower group catches up.

Teacher Facilitation – As the students continue working in groups, circulate around the room to monitor work and make help available only if really needed. The intention of the project is to have the students use their own problem-solving skills and mathematical logic to arrive at the solution. Incorporate the Socratic Method to have the students answer their own questions.

Student Application – Each group solves the problem and satisfies the task set out in the "Insulation Project." Each group also prepares a description of its solution (to be handed in at the end of the lesson) and a brief presentation for fellow students.

Embedded Assessment – Students present how they approached and reached their solution to Homer Depot's problem.

Reteaching/Extension – For those who have not completely understood the lesson, review what is needed.

Summative Assessment:

The major concepts of this short block of lessons are listed on the first page of this CDU, but they are repeated here:

- The ability to link and analyze data using scatter plots and curves of best fit (regression).

- The concept of volume and the linear relationships as one dimension (height) continues to vary.

- Finding points of intersection and interpreting the meaning behind them.

This whole block is an exercise in deepening the students' knowledge of important mathematical concepts that they have previously learned rather than teaching new mathematical skills. The exercises of this block, including completion of the worksheet curves of best fit and the two graphing technology sheets, constitute the summative assessment.

Experience teaching the unit during the 2008-09 school year led to the conclusion that one additional assessment is worthwhile: an oral presentation of results by each team of students. The students were given a grading rubric and instructions on how to give an effective oral presentation communicating quantitative information about a practical, real-world problem. The rubric is enclosed as an information sheet (*Rubric for Oral Presentation*).

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Insulation Project

The Background

Homer owns a house and plans to sell it in two years. Homer knows that he could enhance its value by making it more energy-efficient.

Homer's attic is poorly insulated, and he decides that the best way to make the house more energy-efficient is to install more insulation in the attic. Heat moves through the ceiling/attic of any house. That means heat is lost through the ceiling in the winter (requiring the heater to work harder), and heat flows into the house through the ceiling in summer (making the air conditioner work harder). Insulation in the attic slows down the flow of heat through the ceiling/attic.

As Homer thinks about the cost of putting more insulation in the attic, he wonders if he could save as much money on his energy bill over two years as the insulation would cost. Homer investigates and finds that the savings on his energy bill can be quite significant. He decides that he wants to spend exactly the amount on attic insulation that he will save over the two years he will still own the house.

Homer's average monthly bill for energy is $180. The size of the attic (the area that needs new insulation) can be determined from the dimensions in the following diagram of the house's floor plan:

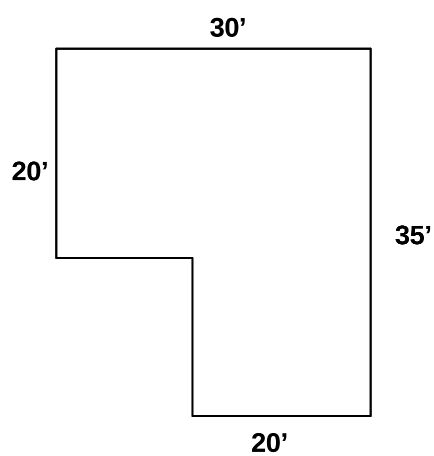


Figure 1

The attic's existing insulation is thin. Homer measures it in several places and finds that it is fairly uniform and averages 2.5 inches deep. Homer's investigation finds that the energy savings from further attic insulation is a function of the depth of new insulation. The data points for energy bill savings in a house like Homer's, as a percentage of the current energy bill, are in the following table:

Depth of New Insulation (inches)	Per Cent Savings on Energy Bill
0.25	1.36
0.75	3.46
1.25	5.0
2.5	7.5
5.0	10.0
7.5	11.25
10.0	12.0
12.5	12.5

Homer wants to keep costs as low as feasible, and so he wants to do the installation work himself (a do-it-yourself project). Installing new insulation in an attic involves purchasing bags of bulk insulation and renting a machine that fluffs up the insulating material and blows it into the attic. Each bag costs $8.97, and each bag contains enough insulation material to fill 16.0 cubic feet. Rental of the machine that blows the insulation into the attic costs $100 per day, and Homer knows he will need only one day to complete the project.

The Problem

Though a jolly fellow, Homer was not the most successful math student in high school. He needs help! How many inches of insulation does Homer need to blow into his attic in order to save exactly the amount on energy in two years to pay for his whole insulation project? And how many bags of insulation does he need to purchase? And what, exactly, is the cost of the project? You need to answer these questions for Homer and prepare an explanation (with graphics as needed) that Homer will understand.

The Group's Task

You are part of a group. Your group's task is to answer the questions for Homer. At the conclusion of the exercise, your group is to present its answers and at least one graphic showing the mathematical relationships and how they relate to the solution.

Advanced Tasks

- Each group create a graph that shows the solution to the problem of the depth of new insulation Homer needs. The graph must be presented with spatial integrity, properly labeled axes, legend, and at least three colors.

- Each group interpret more from the graph generated. There are actually two intersections of the cost line with the savings curve. Interpret the practical meaning of the second intersection point.

- Each group consider not only Homer's objective to break even on his investment, but a further objective: how much can be invested before the marginal investment becomes counterproductive? (This has to do with the slope of the lines for cost, which is a linear relationship, and for savings, which is a logarithmic function.)

- Each group consider a further real effect and what difference it will make for Homer's solution. The effect is this: when insulation is blown into an attic, the insulation compresses slightly under its own weight (the deeper the layer of insulation, the more the compression). So a given amount of insulation material actually covers less volume than predicted; and the deeper the layer of new insulation, the greater the difference is between predicted volume and actual volume (and actual insulation effect). How will this influence Homer's solution? Should he use more insulating material or less than the calculations show?

Solution

What Is Known

To help determine an approach to solving Homer's problem, the student should list the factors that are known:

24 Number of months over which Homer wants to break even on his insulation project
180 Monthly energy bill (dollars)
8.97 Cost per bag of insulation (dollars)
16 Volume of insulation, after blowing into an attic area, in one bag of insulation (cubic feet)
100 Cost per day for renting the insulation blowing machine (dollars)

Also known, of course, is the list of values given in the table for percentage savings:

Depth of New Insulation (inches)	Per Cent Savings on Energy Bill
0.25	1.36
0.75	3.46
1.25	5.0
2.5	7.5
5.0	10.0
7.5	11.25
10.0	12.0
12.5	12.5

What to Find

The student should be clear about what the problem asks. In the words from the statement of the problem:

> Your group's task is to answer the questions for Homer.

And the questions are:

- How many inches of insulation does Homer need to blow into his attic in order to save exactly the amount on energy in two years to pay for his whole insulation project?
- How many bags of insulation does he need to purchase?
- What, exactly, is the cost of the project?

Approach

There are three questions. The answer to the third question depends on the answer to the second, and the answer to the second depends on the answer to the first. The first question is the place to start.

The answer to the first question is a certain number of inches of insulation. That certain number of inches (let x be the inches) costs y dollars, and that same number of inches creates y dollars of savings over the two years Homer will keep the house.
Now the student should recognize the need to define two relationships:

- A relationship between cost of the project and depth of insulation, and

- A relationship between the savings (energy bill over two years) and depth of insulation.

The two relationships can and should be defined as functions, with depth of insulation (inches) as the independent variable, and cost/savings (in dollars) as the dependent variable. Where these two functions have the same value for a given depth of insulation (where the graphs of the functions intersect) is where Homer can break even on his investment.

Cost of the Insulation Project

The cost of the project is simply the cost of renting the machine ($100) plus the cost of the bags of insulation blown into the attic.

$$\text{Cost} = \$100 + \text{bags} * \$8.97$$

The bags can be related to the depth of insulation by calculating the volume:

$$\text{Area} * \text{Depth} = \text{Volume}.$$

The calculation needs to take into account that depth is in inches, whereas volume per bag is given in cubic feet (12 inches = 1 foot).

The student should calculate the area of the ceiling by visualizing two rectangles (one 30’x20’ and one 15’x20’) in the diagram of the house’s floor plan

$$\text{Area} = 30*20 + 15*20 = 600 + 300 = 900 \text{ square feet.}$$

Thus,

$$\text{Bags} = 900\,x\,/\,(12*16)$$

and

$$\text{Cost} = \$100 + (900\,x\,/\,(12*16)\,)\,*\,8.97$$

On a spreadsheet, calculation of the cost for various depths of insulation can be done quickly, and calculations for interim steps (e.g., volume) can be shown. This can help the student relate all the factors from the problem and use "number sense" to check the answers generated. An example from a spreadsheet:

Depth of New Insul. (in.)	Volume (cu. ft.)	Bags	Cost/Bag	Rental	Cost of Insul. Project
0.25	18.75	1.171875	8.97	100	110.51
0.75	56.25	3.515625	8.97	100	131.54
1.25	93.75	5.859375	8.97	100	152.56
2.5	187.5	11.71875	8.97	100	205.12
5	375	23.4375	8.97	100	310.23
7.5	562.5	35.15625	8.97	100	415.35
10	750	46.875	8.97	100	520.47
12.5	937.5	58.59375	8.97	100	625.59

Savings from the Insulation Project

The table of savings values gives the *percentage* savings on the energy bill. To determine the function that relates depth of insulation to savings over two years, a dollar amount needs to be calculated for each percentage figure. The dollar amount is what is saved over two years, or 24 months.

$$\text{Savings} = \text{Percentage}/100 * 180 * 24$$

The savings can be calculated for each depth of insulation given:

Depth of New Insul. (in.)	Per cent savings	Savings, 2 years
0.25	1.36	58.75
0.75	3.46	149.47
1.25	5	216.00
2.5	7.5	324.00
5	10	432.00
7.5	11.25	486.00
10	12	518.40
12.5	12.5	540.00

To generate a smooth curve on a graph showing the relationship between savings and depth of insulation, a function needs to be generated to model the data. This requires use of an appropriate regression model.

The student must enter the depth of new insulation values and corresponding savings values into a table in the graphing calculator. The student then looks at the plot of data and should determine that a logarithmic model would best fit the data. Using the logarithmic regression function of the graphing calculator, the following results:

Generic model equation: $y = a + b \ln x$
$a = 210.7628322$
$b = 131.1576894$

The model function for savings over two years is thus:

$$\text{Savings} = 210.7628322 + 131.1576894 \ln x$$

The student should then graph both functions (cost, savings) on one graph in the graphing calculator, and find the intersection.

When the student has modeled the problem properly and found the intersection, the answer will be:

$$x = .50536954$$
$$y = 121.24921$$

Thus the depth of insulation needed to break even on the investment is 0.5 inches.

The student should recognize that Homer has to buy discrete numbers of bags (he cannot buy a fraction of a bag). The student needs to determine how many bags are required for 0.5 inches, and round up to the next full bag.

Recalling:

$$\text{Bags} = 900\ x\ /\ (12*16)$$

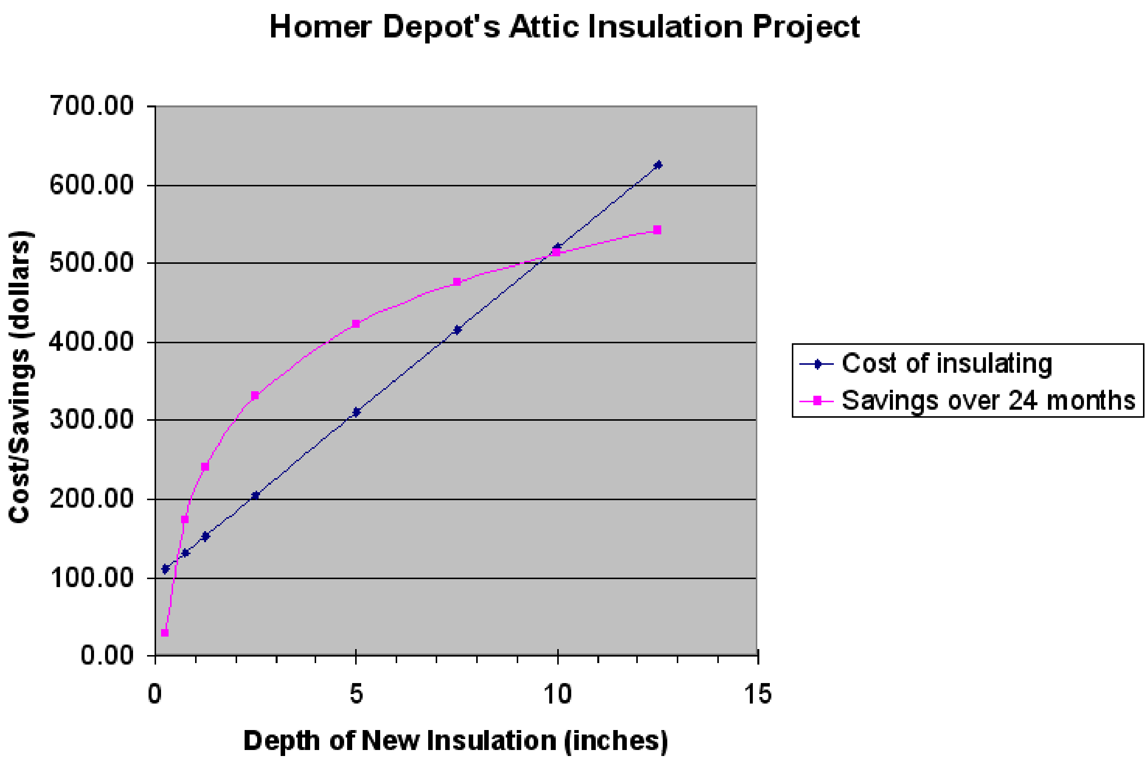
the number of bags is 2.37. This must be rounded up to 3 bags.

Three bags gives a depth of insulation of 0.64 inches. And the cost of the project is $126.91.

Advanced Tasks

- Each group create a graph that shows the solution to the problem of the depth of new insulation Homer needs. The graph must be presented with spatial integrity, properly labeled axes, legend, and at least three colors.

- Solution:



- Each group interpret more from the graph generated. There are actually two intersections of the cost line with the savings curve. Interpret the practical meaning of the second intersection point.

- Solution: At the second intersection point, the cost of the insulation project is the same as the amount saved in two years. After the second point, the cost of the insulation project becomes higher than the amount saved in two years. Between the two intersection points, the savings are greater than the cost of the project.

- Each group consider not only Homer's objective to break even on his investment, but a further objective: how much can be invested before the marginal investment becomes counterproductive? (This has to do with the slope of the lines for cost, which is a linear relationship, and for savings, which is a logarithmic function.)

- Solution: The savings over two years are equal to the cost of the project once Homer puts ½ inch of new insulation in the attic. The savings over two years grow greater and greater up to a point, and then the savings begin decreasing. The point at which the maximum savings can be realized is the point at which the slope of the two graphs is the same, where the depth of new insulation is approximately 2.8 inches. At that point, each additional dollar invested in more insulation yields exactly a dollar in savings; *after* that point, each additional dollar invested in more insulation yields *less than* a dollar in savings. This is the point at which further investment becomes counterproductive.

- Each group consider a further real effect and what difference it will make for Homer's solution. The effect is this: when insulation is blown into an attic, the insulation compresses slightly under its own weight (the deeper the layer of insulation, the more the compression). So a given amount of insulation material actually covers less volume than predicted; and the deeper the layer of new insulation, the greater the difference is between predicted volume and actual volume (and actual insulation effect). How will this influence Homer's solution? Should he use more insulating material or less than the calculations show?

- Solution: The insulation effect is dependent only on the depth of insulating material. The insulating material will compress, which means that less depth will be achieved by a given quantity of insulating material than the calculations predict. This compression will require that slightly more insulation be blown into the attic in order to achieve the insulation effect predicted by the calculations.

TECHNOLOGY SHEET for Scatter Plots and Curves of Best Fit using the TI-83, TI-83 Plus, TI-84 or TI-84 Plus graphing utility: (To facilitate preassessment in lesson 1)

Technology Sheet : ***Graphing Scatter Plots and Curves of Best Fit***

Accessing data lists: press STAT ENTER (STAT EDIT)

To clear any data in your lists, move cursor onto L_1 and press CLEAR ENTER
Repeat for any list necessary.

For data points EX: (1, 2), (3, 4), (5, 6), …place x-values in L_1. Press ENTER after each value.

Move the cursor to L_2 and place the corresponding y-values in L_2.

Drawing Scatter Plots:

Press Y= and clear any expressions in this display.

Press 2ND [STATPLOT] to open Plot 1. If any plots are on you can turn them off by Press 4 ENTER. Return to Plot 1 by Press 2ND [STATPLOT] to open Plot 1. ENTER.
Turn plot ON. Cursor to the first TYPE and highlight. XLIST should be L_1 and YLIST should be L_2. The square mark is easiest to see.

Press ZOOM 9 (Or you could press ZOOM and cursor down to step 9 (ZoomStat) and press ENTER . This automatically gives you a window that accommodates your points.

Finding a Curve of Best Fit:

Press STAT and cursor right to CALC. Determine what type of function (regression curve) you wish to “fit” your data list. Cursor down to the appropriate step. For example: If you wish to “fit” a quadratic function onto your data set you will cursor down to step 5. Hit ENTER This will bring you back to your home screen Hit ENTER again and you have your function with the coefficients listed.
You may then go to Y = and enter this function. Press GRAPH and you can view your curve of best fit.

Or—

Press STAT and cursor right to CALC. Determine what type of function (regression curve) you wish to “fit” your data list. Select the appropriate step and press the number of the step you chose. For example: If you wish to “fit” a quadratic function onto your data set you will press 5 . This brings you back to your home screen. Now press ENTER You now have your function with the coefficients listed.

You may then go to Y = and enter this function. Press GRAPH and you can view your curve of best fit.

But wait! It gets better! ☺

☺ A convenient way to enter your curve into $\boxed{Y =}$ automatically is to press $\boxed{\text{STAT}}$ cursor to $\boxed{\text{CALC}}$ cursor down to the #step you choose (regression choice).   This will bring you to the home screen. **DO NOT HIT ENTER**! Rather follow your regression equation by pressing $\boxed{2^{ND}}$ (L_1)   comma $\boxed{,}$ and then $\boxed{2^{ND}}$ (L_2)   comma $\boxed{,}$ and then $\boxed{\text{VARS}}$ cursor over to $\boxed{\text{Y-VARS}}$ press step $\boxed{1}$ (function) and then press step $\boxed{1}$ (Y1) and press $\boxed{\text{ENTER}}$.

If you now go to your $\boxed{Y =}$ key, you will observe that the regression equation is now in Y1. Press $\boxed{\text{GRAPH}}$.

WORKSHEET: (for preassessment in lesson 1) ***Name:*** ____________________________

Finding Curves of Best Fit: A Quick Review

- **The purpose of this worksheet is to review and reinforce our understanding of scatter lots and lines of best fit. Also to reacquaint ourselves to our graphing utility key strokes.**

Directions: **Using your graphing utility, enter the given data, create a scatter plot with an appropriate window and then determine a curve of best fit for your scatter plot. For problem # 1 and # 2 you are to demonstrate you scatter plot and curve of best fit on the accompanying grid. Label your axes appropriately. For # 3 – 6, determine and write down your curve of best fit. Give accuracy to at least three decimal places.**

1)

X	Y
0	-3.2
2	-1.5
4	5.8
6	9 .9
10	20.6
14	15.0
20	8.8

Curve of Best Fit:

2)

X	Y
-3	200
-2	100
-1	30
0	10
1	9
2	7
3	6

Curve of Best Fit:

____

3)

X	Y
1.3	-20
2.4	-5.62
5.8	1.2
7.6	1.2
10.0	4.5
12.8	4.0
15.6	6.1

Curve of Best Fit: ____

4)

X	Y
-6	10
-4	11
-2	8
0	11
2	5
4	7
6	5
8	4

Curve of Best Fit: ____

5)

X	Y
0	72
1	61.3
2	59.8
3	50.1
4	43.1
5	47.0
6	49.5
7	58.2
8	75.3
9	72.4
10	81.7

Curve of Best Fit: ____

According to your curve of best fit, complete the table (as an extension to table # 5)

16	
	327.4
	64

Name: ________ ***ANSWERS***____________________

Finding Curves of Best Fit: A Quick Review

- **The purpose of this worksheet is to review and reinforce our understanding of scatter lots and lines of best fit. Also to reacquaint ourselves to our graphing utility key strokes.**

Directions: Using your graphing utility, enter the given data, create a scatter plot with an appropriate window and then determine a curve of best fit for your scatter plot. For problem # 1 and # 2 you are to demonstrate you scatter plot and curve of best fit on the accompanying grid. Label your axes appropriately. For # 3 – 6, determine and write down your curve of best fit. Give accuracy to at least three decimal places.

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10	20.6
14	15.0
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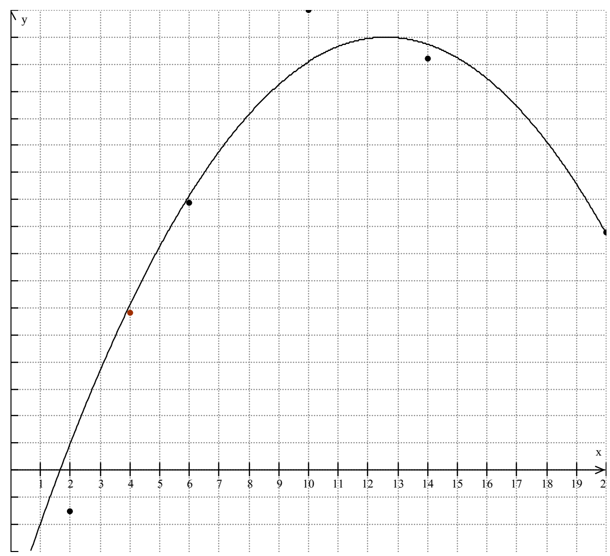
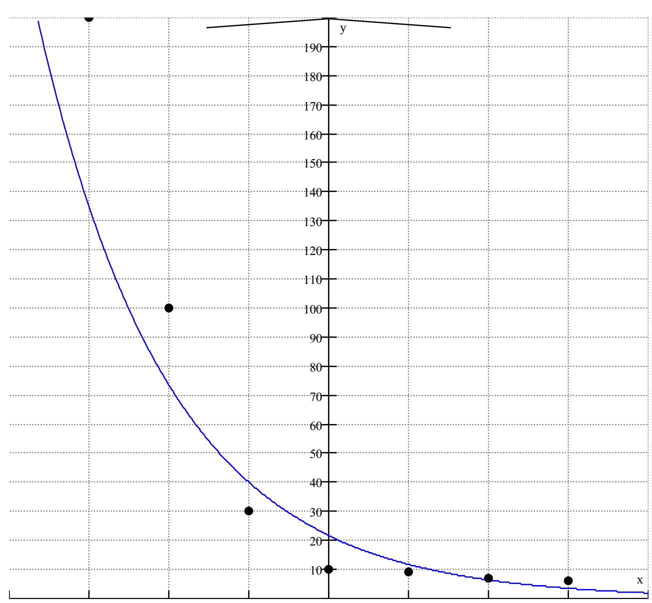


Curve of Best Fit:

$y = -0.149x^2 + 3.694x - 5.662$

2)

X	Y
-3	200
-2	100
-1	30
0	10
1	9
2	7
3	6



Curve of Best Fit:

$y = 21.703(0.544)^x$

3)

X	Y
1.3	-20
2.4	-5.62
5.8	1.2
7.6	1.2
10.0	4.5
12.8	4.0
15.6	6.1

Curve of Best Fit: $y = -18.145 + 9.454 \ln x$

4)

X	Y
-6	10
-4	11
-2	8
0	11
2	5
4	7
6	5
8	4

Curve of Best Fit: $y = 0.482x + 8.107$

5)

X	Y
0	72
1	61.3
2	59.8
3	50.1
4	43.1
5	47.0
6	49.5
7	58.2
8	75.3
9	72.4
10	81.7

Curve of Best Fit:. $y = 1.188x^2 - 10.408x + 71.403$

According to your curve of best fit, complete the table (as an extension to table # 5)

16	**209.0**
19.7	327.4
0.8 or 8.0	64

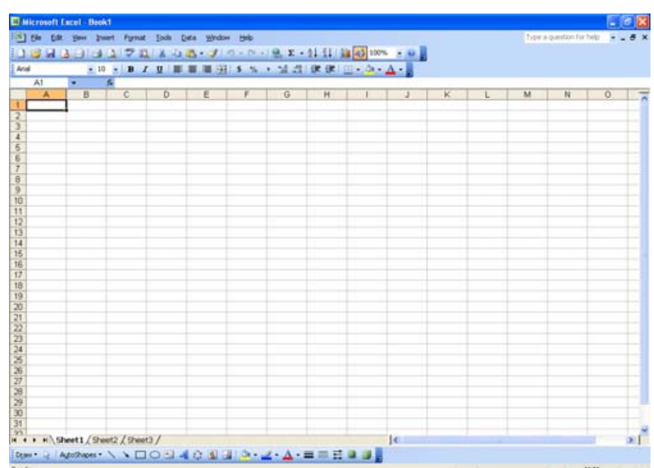
Technology Sheet: ***Generating a Graph in a Spreadsheet Program Part One***

- **Purpose of this worksheet:** To instruct the student about how to generate graphs in a spreadsheet program (in this exercise, the spreadsheet program is Microsoft Excel).

  This gives instructions for Excel, which is a spreadsheet program. There are many other spreadsheet programs, and each program has its own conventions for entering and manipulating data.

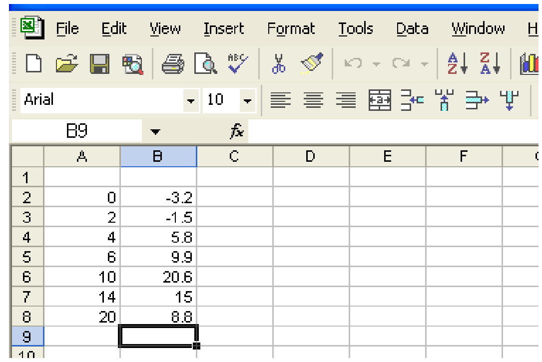
Open Excel. To do this, click on the "start" button, then click on the icon for Microsoft Office Excel. If the icon is not visible, then move the cursor over "All Programs" and wait a second; the menu for all programs will pop up. Move the cursor to "Microsoft Excel" and click. If you still don't see Excel, find "Microsoft Office" programs and follow the cascading menus until you can click on Excel.

Excel opens and displays a worksheet. If a menu asking about formats or templates comes up, try to navigate past the options, so a simple spreadsheet is displayed. Save it as a new document, and give it a name (File > Save As…; then type a name for the document; then click on the button "Save.")



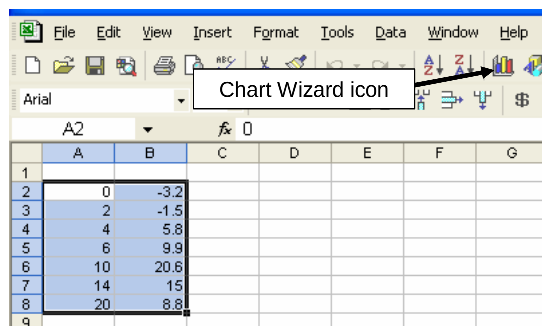
Enter data:

- Move the cursor over the cell where you want to start (in the example to the right, data entry starts in cell A2). Click on the cell. You will see then that the cell is outlined by a heavy border, indicating that the cell is active, or ready for input.
- Type the data you want in the cell, and then push "Enter." The data are now entered, and the next cell down is active.
- When you wish to enter data in a cell different from an active cell, just click on the different cell.
- If you want to enter data in the next cell to the right, push "Tab" instead of "Enter."
- Note that it is important to keep data pairs (x, y values) next to each other, or on the same row.

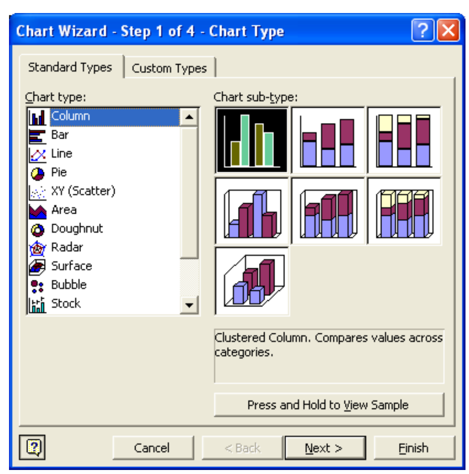


Generate a graph of the data. Begin as follows:

- Highlight all of the data (click on the top left cell and drag over the rest of the cells).
- Click on the "Chart Wizard" icon.
- See example to the right.

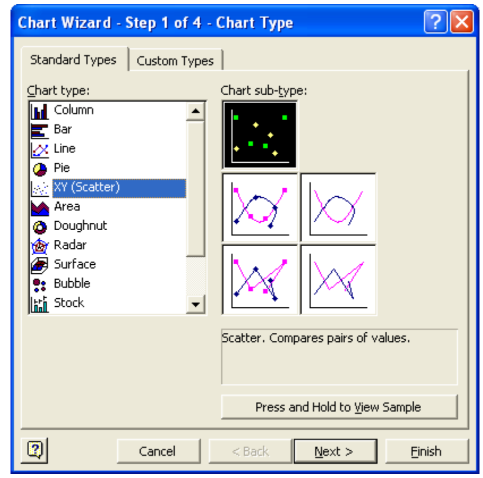


A new window appears (see example to the right). Note that the title of the window, in the top blue band of the whole window, includes "Step 1 of 4."



In the “Chart type” pane, click on “XY (Scatter).”

Then click on “Next” (button on the bottom of the window).

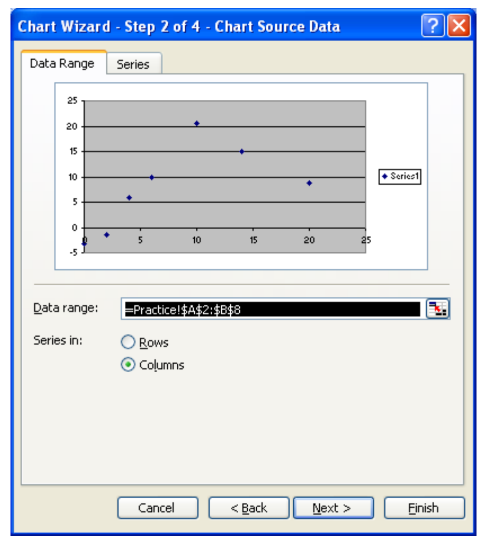


A new window appears (see example to the right). The title of this window has “Step 2 of 4.”

Click on “Next.” Another new window appears (title of this window has “Step 3 of 4”).

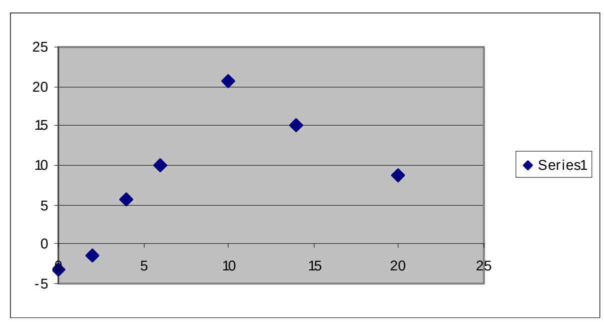
Click on “Next.” Yet another new window appears (title of this window has “Step 4 of 4”).

Click on “Finish.”



A graph appears. It should appear similar to the graph here:

Print the graph out. Follow teacher’s instructions for placing name or team identity on the printout.



You may have noticed, as you clicked “Next” on the different “Steps” of generating the graph, that there are many additional things you can do to the graph. You can label axes, label the legend, change colors, change the way the lines/dots appear, and many other things. You can go back and edit the chart after it is created. You will learn more about that in the next technology sheet exercise.

Technology Sheet: ***Generating a Graph in a Spreadsheet Program Part Two***

- **Purpose of this worksheet:** To expand the student's knowledge about how to generate graphs in a spreadsheet program (in this exercise, the spreadsheet program is Microsoft Excel). We will use problem # 1 on the worksheet *Finding Curves of Best Fit*: *A Quick Review* for the example.

  This sheet gives instructions for Excel, which is a spreadsheet program. There are many other spreadsheet programs, and each program has its own conventions for entering and manipulating data. Note: There are several versions of Excel. These instructions were generated using Excel 2003 SP3 ("SP3" meaning "Service Pack 3"). Some of the instructions here may not be accurate if you are using a different version of Excel, but all versions of Excel since the mid-1990s should be able to provide all of the features in these instructions.

Directions: **The data points to be graphed are in the table below. The equation of the curve of best fit is below the table (your previous work should verify this). The instructions explain how to build the graph in Excel with a tailored legend, correctly labeled axes, and a chart title.**

1)

X	**Y**
0	-3.2
2	-1.5
4	5.8
6	9 .9
10	20.6
14	15.0
20	8.8

Best fit line/curve equation: $y = -.14868x^2 + 3.6936x - 5.6622$

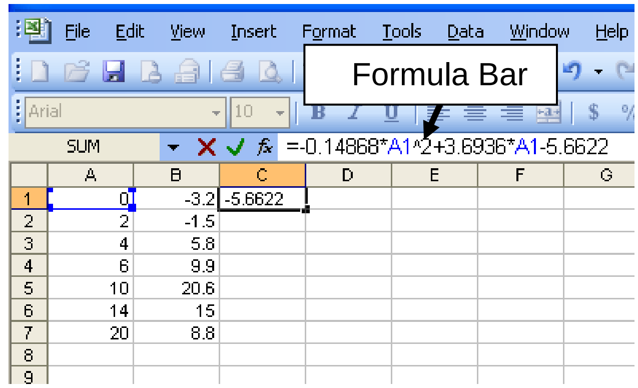
Open Excel.

Excel opens and displays a worksheet. If a menu asking about formats or templates comes up, try to navigate past the options, so a simple spreadsheet is displayed. Save it as a new document, and give it a name (File > Save As…; then type a name for the document; then click on the button "Save").

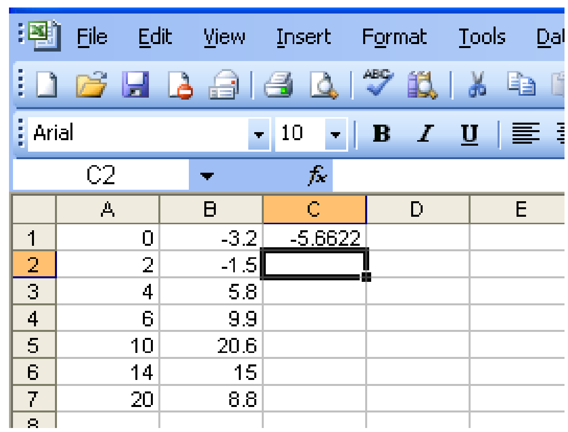
Enter the data in two columns. Begin with cell A1 (upper left cell of the spreadsheet). For this exercise, beginning with cell A1 is important because these instructions are accurate only if data entry starts in cell A1.

In the third column (beginning in cell C1), enter the equation of your line/curve of best fit:

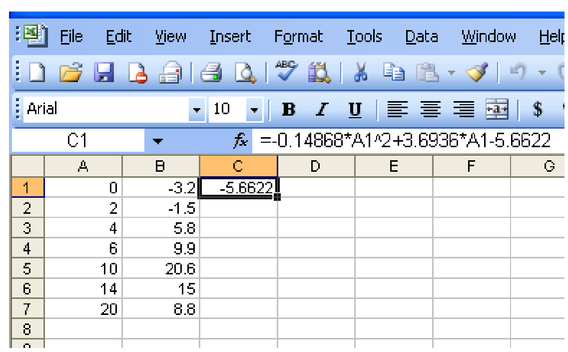
- Click in cell C1.
- Type "=" (and don't do ANYTHING ELSE YET)
- Type the formula for your line/curve of best fit. Where x appears in the formula, don't put "x;" instead, put the cell name (for example, "A1") where the appropriate x-value is. See example to the right.
- Note that your formula appears in the Formula Bar (see example), and you can click in the Formula Bar to edit what you type.



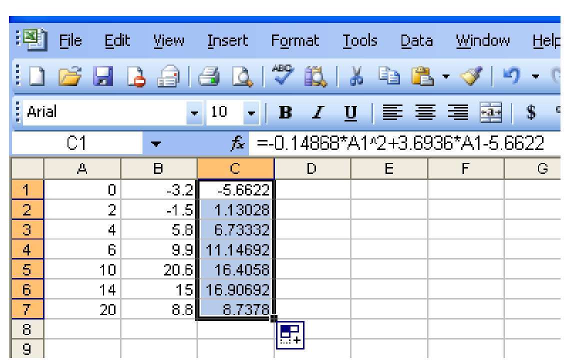
Push "Enter." A number appears in the cell. The number is the function value that corresponds to the x-value in column A. See example to the right.

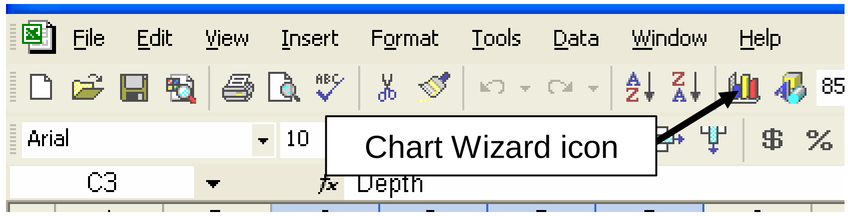


Click on cell C1 again. Note that lower right corner of the border has a dot, or small square (see example to the right). Place the cursor exactly—*exactly*—on the small black square; left click on it, and drag down several cells.



This fills the formula you entered (previous step) in all the cells you drag over. Be sure to drag down as far as needed to cover all the x-values you want plotted. Your window should appear as in the example to the right.

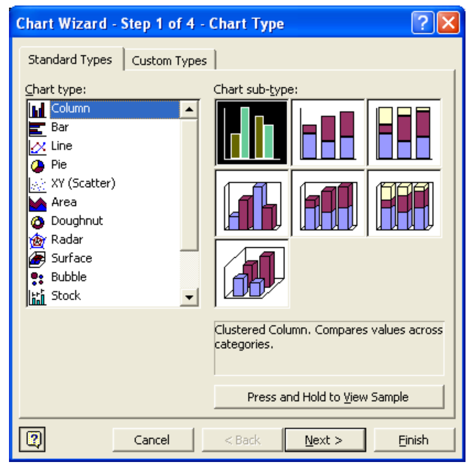




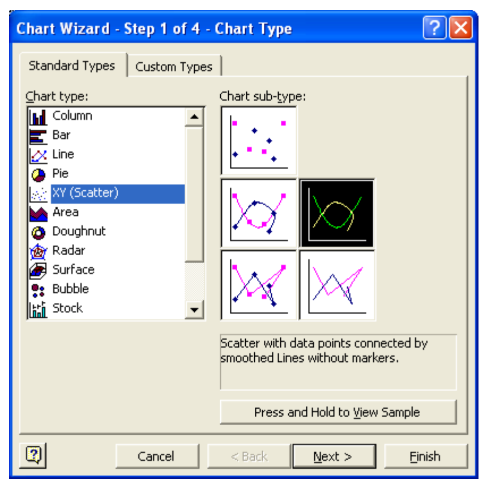
Next, create the graph of your data.

Highlight the entire set of data that you have created (all three columns). Then click on the Chart Wizard icon on the menu bar (see picture to the right). This generates a new window (example is below and to the right).

In the "Chart type" pane, click on "XY (Scatter)."

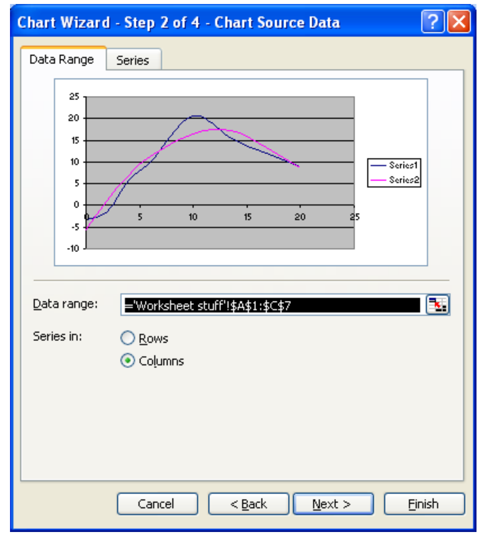


When you click on "XY (Scatter)," the "Chart sub-type" examples will change. Click on the chart sub-type shown in the example to the right. Then click the "Next" button on the bottom of the window.



The window to the right appears.

Click on the data “Series” tab.



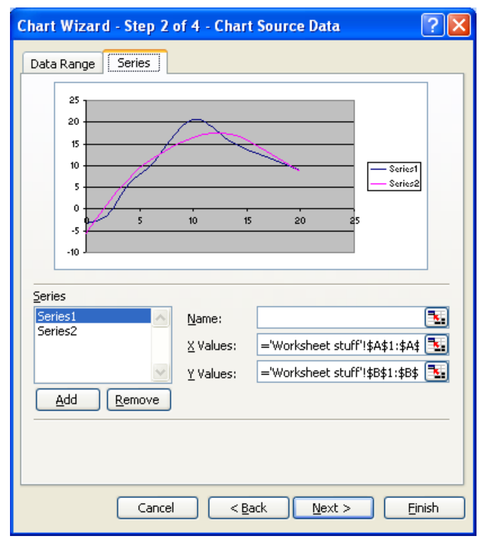
The window to the right appears.

Note that “Series1” is highlighted. The three panes to the right have information about the series. “Series1” has no “Name.”

Click in the “Name” pane, and type a label for the series of data points. Type “Actual Data” here.

Click on “Series2” in the “Series” pane. Then click in the “Name” pane, and type a label for the best-fit line/curve. Type “Best-Fit Curve” here.

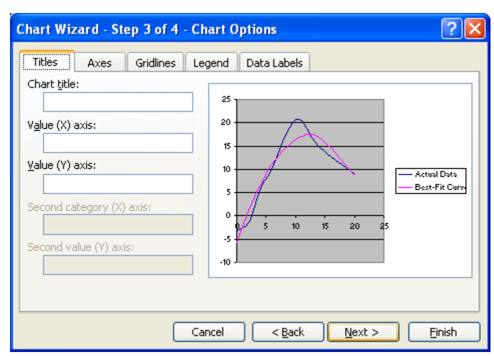
Click on “Next.”



A new window appears (see example to the right).

Click in the “Chart Title” pane, and type in the name you want for your chart. You can also use the chart title to add additional information (such as your equation that models the data). Type “Example 1.”

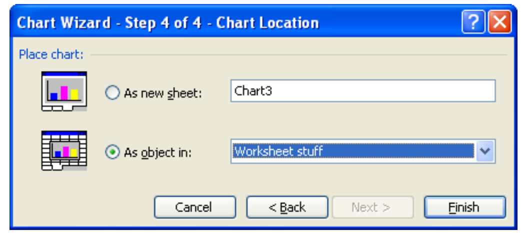
Click in the “Value (x)” pane, and type in the label you want for your x-axis. Type “Domain.”



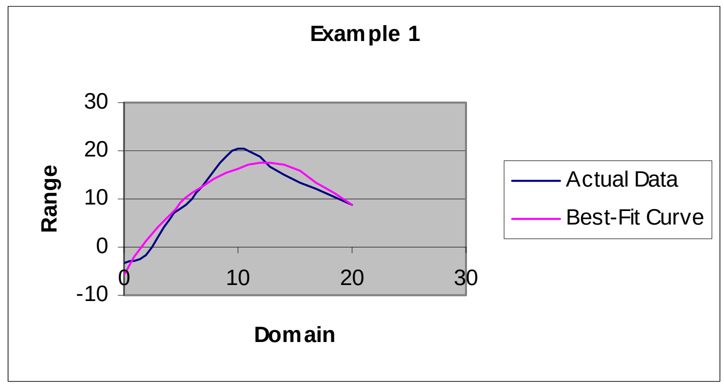
Click in the “Value (Y)” pane, and type in the label for your y-axis. Type “Range.” Click “Next.”

A new window appears. See example to the right.

Click “Finish.”

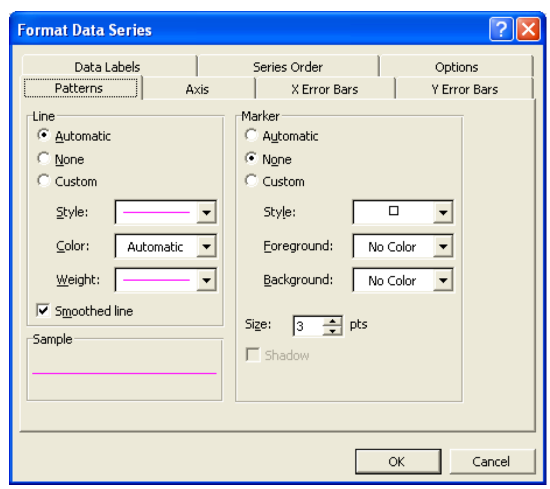


Your completed graph pops onto your spreadsheet. It should appear similar to the example to the right.



At this point, you can edit any aspect of the graph. You can right-click anywhere on the chart to get a menu of things you can change. You can also double-click on any part of the chart to bring up a window for editing the part of the chart on which you double-clicked.

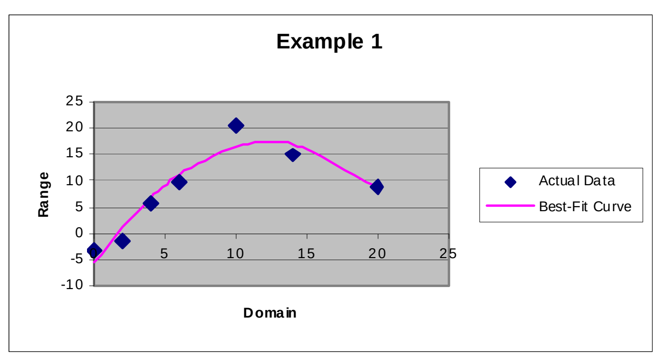
One thing you should edit is the graph of actual data points. Place the cursor on the line that graphs those points (be sure you aim carefully), and double-click. A new window appears. See example to the right.



In the “Line” part of the window, click on the radio button “None.” In the “Marker” part of the window, click on the radio button “Automatic.” Then click “OK.” This changes the graph of the actual data to points that are not connected by a line.

Click “OK.”

You should see the graph as in the example to the right.



Print the graph out. Follow teacher’s instructions for placing name or team identity on the printout.

Information Sheet: ***Rubric for Oral Presentation***

- **Purpose of this information sheet:** To assist students in understanding how to communicate quantitative information. The rubric is tailored to the Insulation Project.

Grading Rubric for Oral Presentations

Graded Element	3	2	1	raw	Weight	Grade
PowerPoint file submitted in time	By 7:00 AM of day of presentation	Same day	Later		2	
Delivery of ppt file	By e-mail from school account	By e-mail from another account			2	
Opening	Student gets others' attention and engages them immediately at the start	Student makes an attempt to get others' attention	Student starts competently but without an obvious attempt to get attention		2	
Maintain attention	Student identifies and takes action to re-engage students whose attention wanders	Student maintains good presentation but misses re-engaging wanderers	Student's style is OK, but actions do not address those whose attention wanders			
Voice	Clear enunciation; appropriate volume; good voice modulation	Minor issues with enunciation, volume, or modulation	Significant issues with enunciation, volume, and/or modulation			
Eye contact	Good eye contact throughout, with attention to all parts of the audience	Good eye contact sometimes; attention given to only part of the audience	Occasional eye contact with some of the audience			
Gestures and movement	Body movement and gestures alive; appropriate to the topic; and support the communications	Body movement and gestures indifferent but still support the communications	Stiff or stilted presentation and/or distracting gestures			
Closing	Clearly articulated close to the presentation with a "bottom line"	Close is obvious though not articulated	Presentation trails off without clear ending			
Questions	Student asks for and answers well any questions; student repeats questions that might be hard for all of the audience to hear; student elicits or asks questions to start two-way communication	Student asks for and answers any questions	Student does not indicate that questions are welcome			
Slides/aids	Slides/aids support and enhance presentation; student stays in sync with slides and points (in a non-distracting way) when appropriate	Slides/aids support weakly or do not contribute.	Slides/aids distract from the effort; student's pointing is distracting			
Sources and/or quality enhancements	Student explains about identity and quality of sources	Student identifies sources (but does not comment on quality)	Student brings source material in but does not identify sources			
Overall tone	Student makes a serious and sincere effort to communicate and succeeds with message. Humor is a plus as long as it supports the sincere communications effort.	Student makes an honest effort to communicate and maintains a tone that supports the communication.	Student goes through successful motions of communicating effectively but lacks a serious and sincere tone. (Zero for a tone that makes a joke of the requirement.)		5	